NRIC National Reactor Innovation Center

National Reactor Innovation Center

Partnering with industry to deploy advanced nuclear at the speed of a startup

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MIS-25-85413

The National Reactor Innovation Center (NRIC) is a DOE program launched in October 2019

NRIC Enables Nuclear Reactor Tests & Demonstrations

- Authorized by the Nuclear Energy Innovation Capabilities Act (NEICA)
  - Department of Energy (DOE)-Office of Nuclear Energy
  - Headquartered at Idaho National Laboratory (INL) and part of Nuclear Science & Technology Directorate
- Partner with industry to bridge the gap between research and commercial deployment
- Leverage national lab expertise and infrastructure

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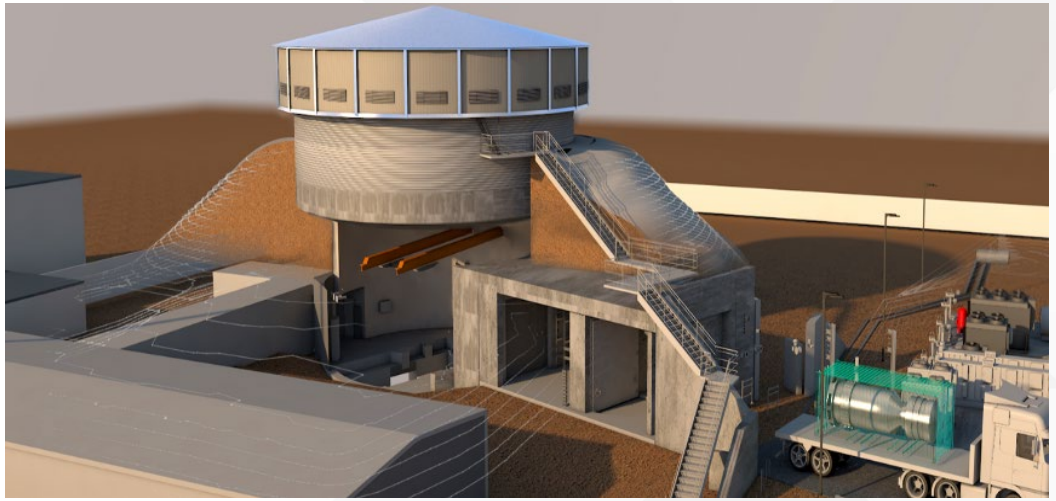
NRIC Portfolio Built to Empower Innovators



- **Advancing Reactor Testing**
  - Advanced Reactor Test Beds
  - Siting Advanced Reactors
  - Experimental Facilities
  - Virtual Test Bed

- **Addressing Costs & Markets**
  - Advanced Construction
  - Digital Engineering for Nuclear
  - Maritime Applications

Portfolio created to fill gaps identified by industry

NRIC-DOME Test Bed

Demonstration of Microreactor Experiments (DOME)

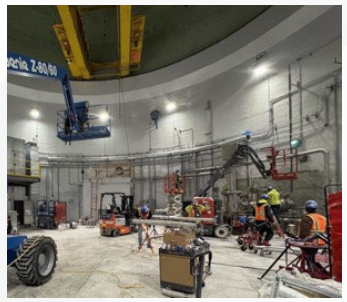
- DOME repurposed EBR-II structure
- Designed for Advanced Microreactors up to 20 MWth
- Designed for high-assay low-enriched uranium (HALEU) fuels <20% enrichment

Recent milestones:

- Facility Readiness Review plan submitted to DOE-ID Dec. 18, 2025
- Documented Safety Analysis submitted to DOE-ID Jan. 15, 2026

Upcoming milestones:

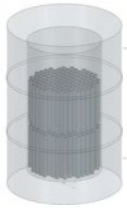
- Construction anticipated complete date March 31, 2026 (accelerated a year from originally scheduled for March 2027)
- Ready for Radiant's Kaleidos Demonstration Unit first installation April 2026



DOME Ecosystem

Performing reactor experiments takes more than just the DOME facility. It requires integration of additional infrastructure, partners, procedures, and processes.

TRISO Fuel manufacturing

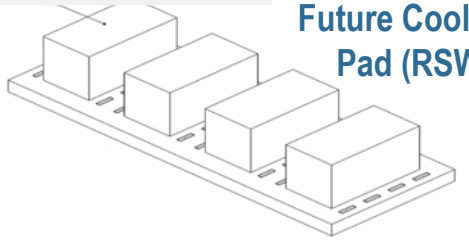


Fuel shipping

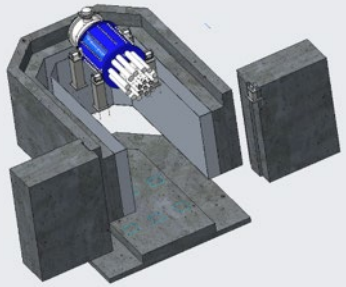
Storage in CPP-651

Reactor

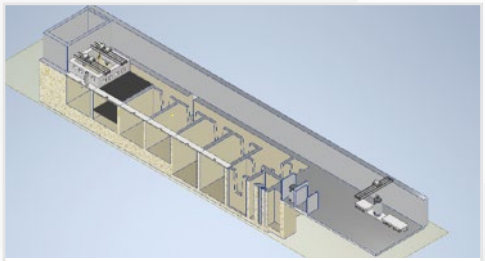
Reactor footprint



Future Cooldown Pad (RSWF)



Reactor shielding



Defuel & dispose reactor

Used fuel

RSWF used fuel storage

Reactor

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Radiant Kaleidos Demonstration Unit (KDU)

Kaleidos Demonstration Unit Arriving at the NRIC DOME

Reactor Description:	Gas-Cooled, HALEU TRISO Fueled Micro-Reactor. Helium Turbine Electricity Generation, Place and Replace Design

General Information

Power:	**3.5 MW(th)**
License Authority:	**DOE Authorization**
Location:	**NRIC-DOME**
Target Operation Date:	**June 2026**

Critical Dates

11/15/2025 – NSDA submission to DOE-ID
11/17/2025 - PDSA submission to DOE-ID
3/31/2026 – DSA submission to DOE-ID
4/13/2026 – KDU arrives at INL
5/27/2026 – KDU Fueling
6/18/2026 – KDU Criticality

NRIC-LOTUS Test Bed

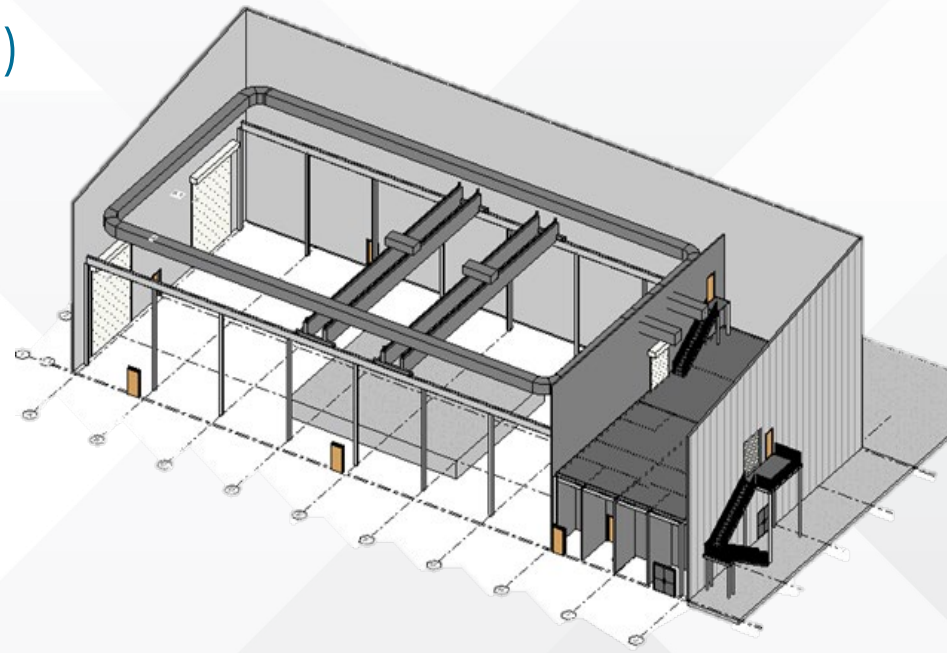
Laboratory for Operations & Testing in the US (LOTUS)

STATUS

- Original scope intended to repurpose Zero Power Physics Reactor structure
- Pivoted to new building due to increased costs of original project scope
- New facility design/build request for proposals – Mid-2026
- Targeting construction completion - 2028

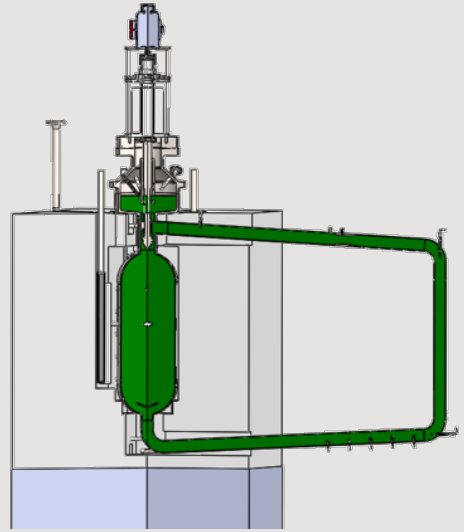
FEATURES

- Designed for >20% enriched high security fuels
- Performance based security posture
- 7,000 ft^2 experiment area with 4,000 psf floor bearing capacity
- (2) 15 ft-wide by 20 ft-high doors
- (2) 25-ton cranes; 30 ft to bottom of crane hook
- Redundant building heat removal - 50 kWth each
- Ventilation system with radiological monitoring
- Instrument air and Argon gas systems available
- Available uninterruptable power supply, standby power – diesel generator



Molten Chloride Reactor Experiment (MCRE)

- A 12-month sub-scale test to demonstrate the first operational, fast-spectrum, molten salt critical system in the world.
- NRIC-LOTUS test bed
- Public-private partnership (Southern Co., TerraPower, CORE POWER) under DOE Office of Nuclear Energy's Advanced Reactor Demonstration Program
- Startup target 2028



Completed Milestones:

- 2024: 95% fuel conversion (uranium metal to uranium chloride), full-batch production
- Fall 2025: first full-scale production of enriched fuel salt

Upcoming milestones

- Production of five fuel salt batches using FSSL (Sept. 30, 2026)

Nuclear Energy Executive Orders

- Reinvigorate the Nuclear Industrial Base
- Reform Nuclear Reactor Testing at DOE
- Deploy Advanced Nuclear Reactor Technologies for National Security
- Reform the Nuclear Regulatory Commission

President Donald Trump holds up a signed executive order in the Oval Office of the White House May 23, 2025 in Washington, DC. Win McNamee/Getty Images

DOE selected advanced reactor projects to move technologies towards deployment

Aalo

TERRESTRIAL ENERGY

OKLO

RADIANT

ANTARES

Natura Resources

LAST ENERGY

VALAR ATOMICS

DEEP FISSION

ATOMIC ALCHEMY

"President Trump's Reactor Pilot Program is a call to action. These companies aim to all safely achieve criticality by Independence Day, and DOE will do everything we can to support their efforts."

James P. Danly,
Deputy Secretary of Energy

DOE Advanced Nuclear Fuel Line Pilot project selections

TRISO

OKLO

TERRESTRIAL ENERGY

STANDARD NUCLEAR

VALAR ATOMICS

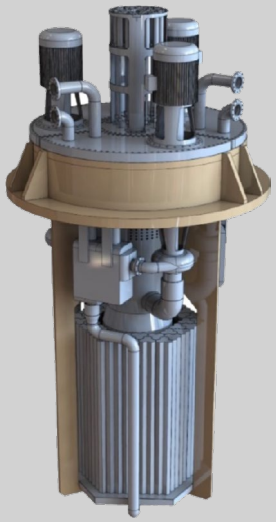
The Fuel Line Pilot Program supports the Reactor Pilot Program by establishing a domestic nuclear fuel supply chain for testing new reactors. It uses DOE authorization to build and operate nuclear fuel production lines for research, development, demonstration, and expedited commercial licensing.

Oklo Aurora Reactor & Fuel Fabrication Facility

- **Sodium-cooled fast reactor based on proven technologies developed at INL (e.g., EBR-I, EBR-II)**
- **Aurora Reactor**
  - DOE Authorization through Pilot Program
  - 75 MWe
  - Groundbreaking Sept 22, 2025
  - Goal to begin operation in 2028
- **DOE competitively awarded Oklo with 5 MT of HALEU material recovered from EBR-II driver fuel**
  - Fuel fab facility to be constructed at MFC
    - DOE authorized
    - PDSA approved by DOE – Dec 8, 2025

Aalo-X Reactor

- **Aalo Atomics**
  - Selected for DOE Reactor Pilot Program
  - Signed Other Transaction Authority (OTA) agreement with DOE
  - Planned as DOE authorized test
- **Aalo-X Reactor**
  - Liquid Metal Reactor, Sodium Cooled Thermal Reactor
  - UO2 fuel pins and graphite moderated core
    - Final design under development
  - 30 MWth
- **5% enriched UO2**
  - Aalo signed agreement with Urenco to supply fuel
- **Groundbreaking held August 28 after receiving the Environmental Compliance Permit**
- **Aalo's goal is to have a dry criticality experiment by July 4, 2026**



Critical Assembly Facility
Home of the Zero Power Dry Criticality Experiment

Antares R1 Demonstration

- **Antares**
  - Selected for DOE Reactor Pilot Program
  - DOE Other Transaction Authority (OTA) agreement – Sept 2025
  - Planned as DOE authorized test
- **Antares R1 Reactor**
  - Sodium Cooled Heat Pipe Reactor
  - Graphite moderated core
  - TRISO fuel compacts
  - 1-3 MWth, scalable to higher power levels
- **TRISO Fuel: 19.75% enriched U-235**
  - Contract with BWXT to manufacture fuel
- **INL is cleaning/modifying MFC-793 to establish the Reactor and Critical Experiment (RACE) Facility**
- **Mark-0 Test: Dry criticality experiment by July 4, 2026**
- **Mark-1 Test: Full R1 reactor test - 2028**

Antares R1 Reactor

MFC 793

RACE Test Bed

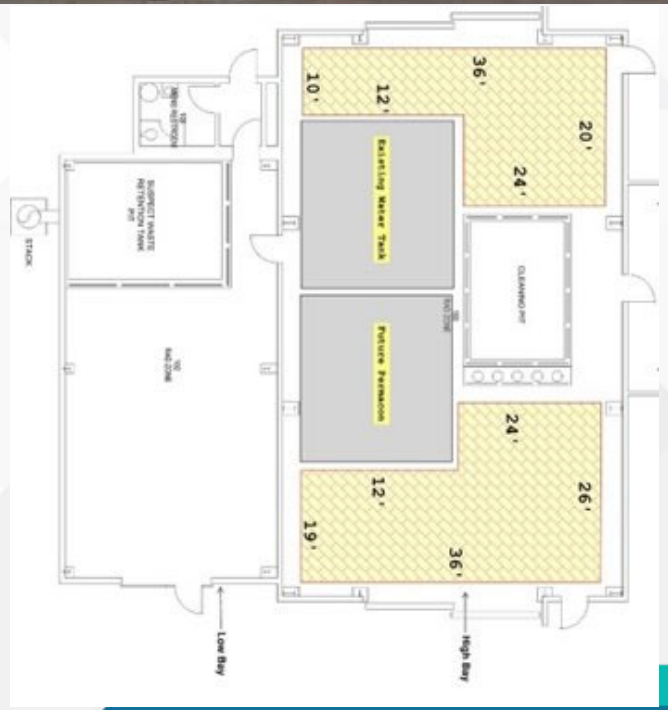
Reactor And Critical Experiments (RACE) Facility

FEATURES

- Facility structure originally housed ML-1 reactor in 1960s (structure moved to MFC in 1970's)
- Currently supports MFC sodium waste management activities
- 32' tall × 20' wide rollup door access to high-bay to facilitate reactor installation
- 30-ton crane with 2ea 15-ton trolleys; 32 ft max hook height to facilitate reactor assembly
- 5-ton crane; 32 ft max hook height to facilitate reactor assembly
- 10' wide x 15' long x 20' deep pit to support reactor testing

STATUS

- Modifications underway to support upgrade to Hazard Category 2 nuclear facility
- Being developed to support defense and space reactor systems
  - Antares
  - VALKRE
- Initial construction completion mid 2026 to support Antares Pilot project initial criticality test and then VALKRE demonstration
- Targeting final construction completion in 2027 to support Antares full reactor test



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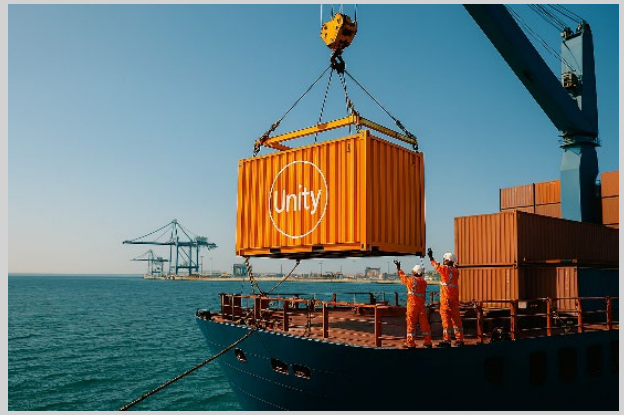
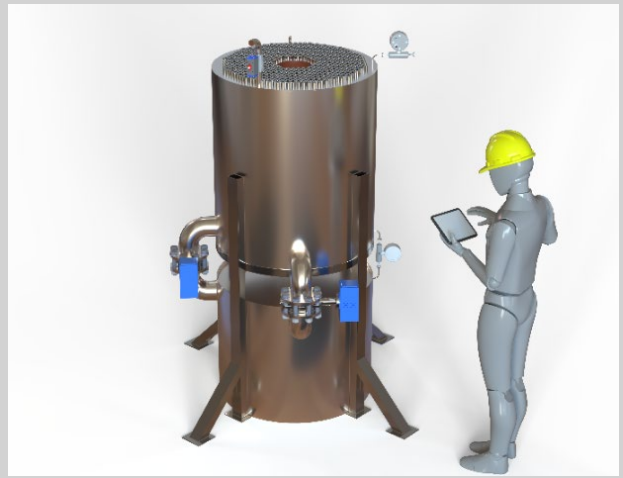
Unity Nuclear Battery

- **Deployable Energy**
  - SPP and PTS approved and active Jan 2026
  - Contract covers development of Water Tank Zero Power Criticality Experiment
  - Plan is to execute test under SPP
- **Unity Nuclear Battery**
  - Light-Water Moderated – Helium Cooled
  - 4.95%% LEU UO2 fuel
    - Contract with Westinghouse to deliver fuel by April 2026.
  - 3 MWth – 1 MWe
- **Goal is to conduct criticality experiment by July 4, 2026**
- **This test will validate neutronics modeling and confirm the Unity core design using LEU fuel and water moderation.**
- **After this test Deployable intends to continue to work with INL for additional criticality experiments and eventually a First of a Kind (FOAK) reactor demonstration.**





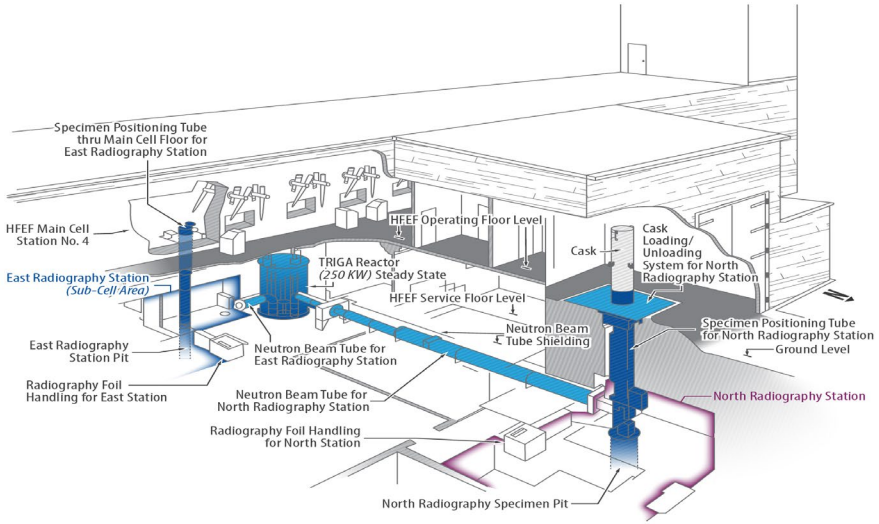
Water Tank Zero Power Criticality Experiment

NRAD NRS (2N) Test Bed

Neutron Radiography (NRAD) Reactor North Radiography (NRS) Station Test Bed

Overview:

- Located below MFC's Hot Fuel Examination Facility (HFEF)
- Built in 1979 for neutron imaging; reactivated in 2015
- Supports reactor demonstrations without impacting NRAD operations
- Separate space and SAR from HFEF



Key Attributes:

- Staff of certified Reactor Operators and Senior Reactor Operators
- HEPA filtered exhaust with stand-alone stack
- Personnel entry to NRS via 11.5-ton shield door
- 18' tall × 14' wide rollup door access to high bay
- Sufficient floor loading capacity for microreactors
- 30" diameter "pit" that extends below the shielded cell 34' (also seismically rated)
- Removable shield plugs with 4'×4' vertical access shaft connecting high bay to NRS
- HAZCAT 2 CAT B Reactor Facility
- Existing radiation shielding, 6' thick concrete walls
- Working 5-ton bridge crane
- Fission chambers with associated instrumentation are available
- Seismically rated
- Safety Significant shielding AND structure
- Potentially NO FACILITY MODIFICATIONS needed for small, low/zero power reactor demonstrations
- Does not hinder NRAD operations
- Zero impact to HFEF operations

Standard Nuclear Fuel Fabrication

Standard Nuclear is building advanced nuclear fuel production facilities focused on TRISO fuel for next-generation reactors.

Current facility located in Oak Ridge, TN producing 350kgU per year

- Two more planned facilities (one at Oak Ridge, one at INL), both planned to produce 1000kgU per year
- DOE authorization for all facilities

INL supporting development of Standard Nuclear facility programs and submittals for DOE authorization

Status:

- Signed OTA with DOE – September 2025
- Received DOE Authorization for SN-0 – January 2026
- Commenced fabrication of Radiant KDU fuel – January 2026
- Delivery of Radiant Fuel to INL – May 2026

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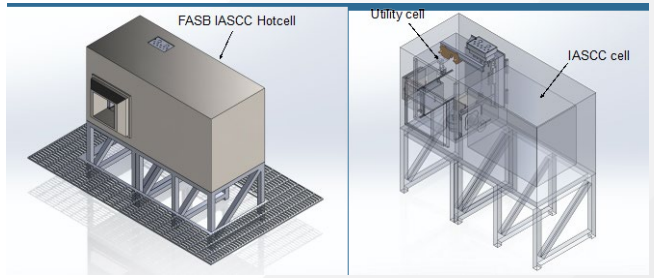
NRIC Experimental Infrastructure

Helium Component Test Facility [*2022*]

Mechanisms Engineering Test Lab (METL) [Operating since 2018]

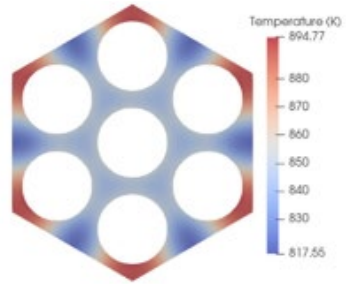
Molten Salt Thermophysical Examination Capabilities (MSTEC) [*2026*]

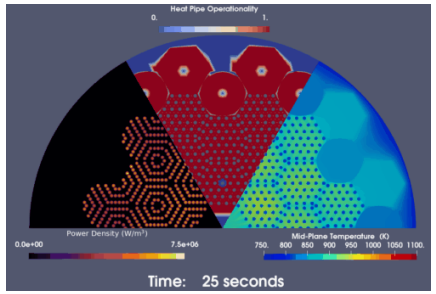


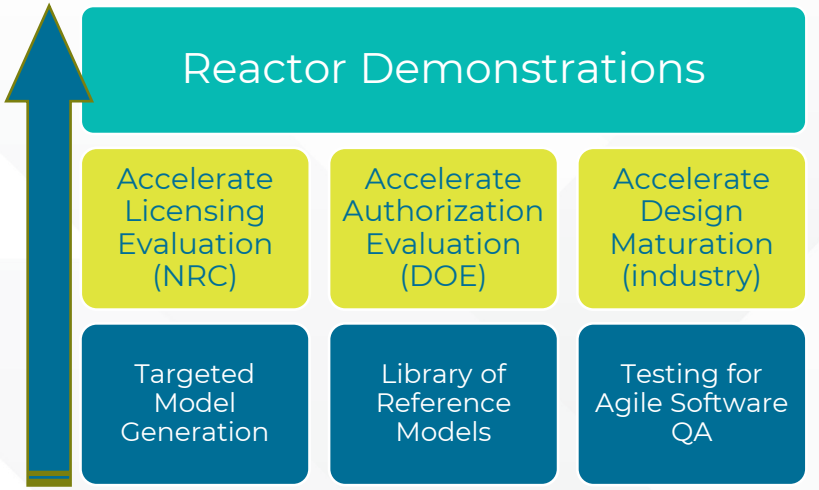
In-HotCell Thermal Creep Frame [*2025*]

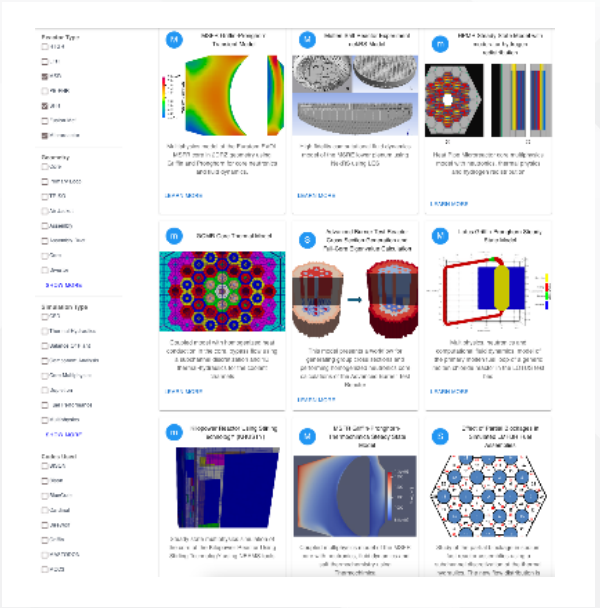
NRIC – Virtual Test Bed (VTB)

- Central location for reactor developers/stakeholders to access and leverage state-of-the art ModSim models of advanced reactors to evaluate performance and safety.
- Cross-laboratory and cross-program collaboration between NRIC and DOE Nuclear Energy Advanced Modeling and Simulation (NEAMS) program.
- Repository/library of simulations for liquid metals, gas cooled, molten salt and micro reactors (continuously tested).
- Currently hosting 60+ distinct models with 15 NEAMS codes with a user-friendly search engine.









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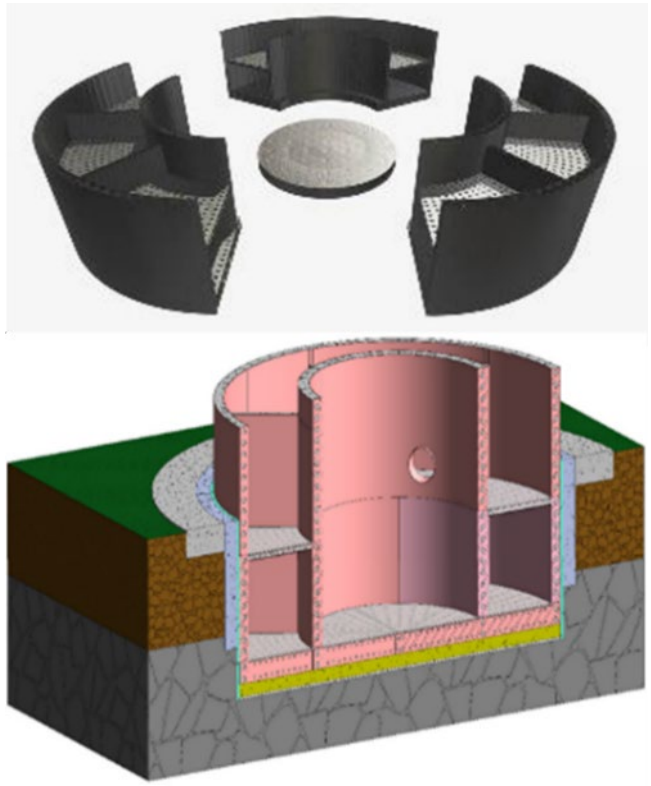
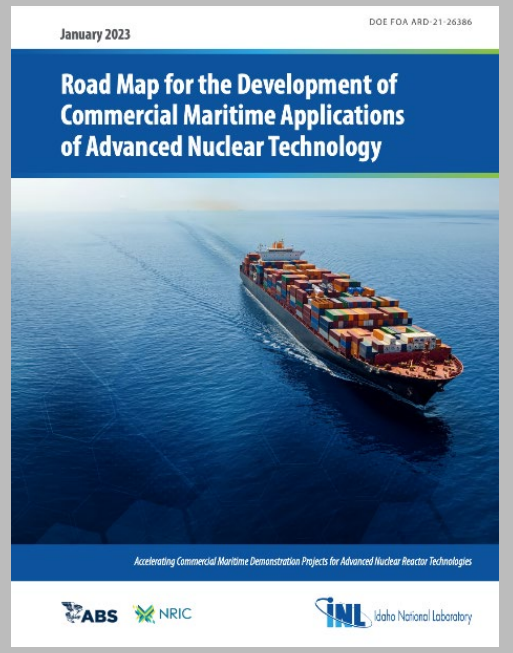
Addressing Cost and Markets



- Advanced Construction Technologies
- Digital Engineering & Knowledge Sharing/Lessons Learned
- Demonstration/Deployment Opportunities (Maritime)



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Advanced Construction Technologies

Demonstrate Technologies

- Reduce cost of new SMR builds by 10%+
- Compress construction schedule by as much as 25%
- Reduce required site work & improve overall quality of structure
- Support long-term structure monitoring

Phase One Recent Accomplishments

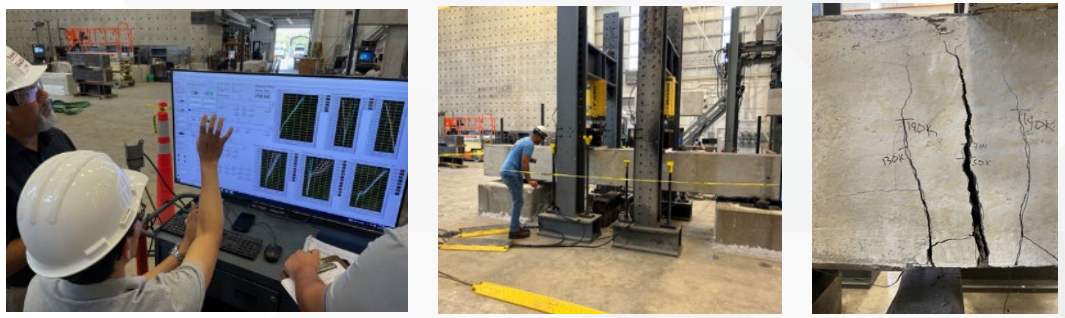
- Purdue DPSC testing complete & successful 11/18/24
- 10 CFR 851 determination received from DOE HQ GC 11/15/24

Optional Phase Two

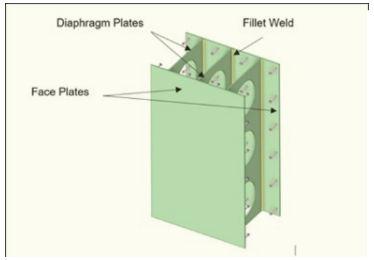
- Demonstrate 60-degree pie shape containment walling system
- Inner and outer walls, base mat integration, multi-story
- Deploy digital twin plus sensor technology for monitoring
- NDE Execution and Deployment
- NRC Engagement & Decommissioning

Team – General Electric Vernova

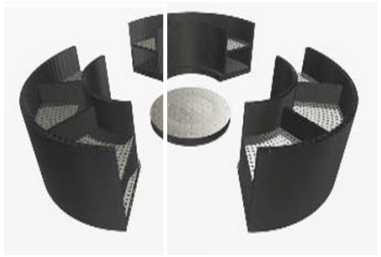
EPRI, Black & Veatch, Purdue, UNCC, Aecon, and Tennessee Valley Authority



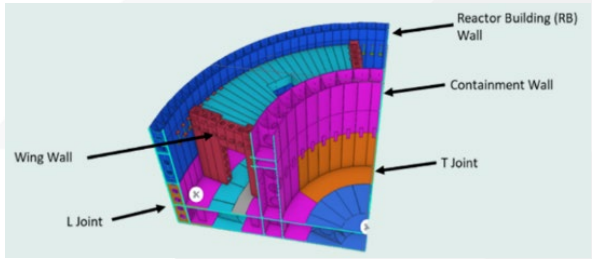
Testing DPSC samples at Purdue



Diaphragm Plate Steel Composite (DPSC)



Modular Wall Concept



Proposed Phase II containment system

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Digital Engineering (DE)

- What? An integrated digital approach that uses authoritative sources of truth for data and models across disciplines to support project lifecycle activities from concept through disposal.
- Why? With typical industry project cost overruns of 241% and 180% in schedule delay, digitization of the overall processes can have a significant impact on nuclear deployment and cost viability.
- **Implementation Process & Progress to Date**
  1. Transform the way organizations generate design data by deploying model-based tools: IBM DOORS Next, Innoslate MBSE, PTC Creo, Autodesk Revit, etc.
  2. Transform the way organizations manage, store, and connect data using digital threads to form a comprehensive digital ecosystem: PTC Windchill, INL Deep Lynx Warehouse, software adapters & APIs, etc.
  3. Transform the way organizations leverage data using digital twin technology: extended reality (XR), Unity game engine, real-time data acquisition (DAQ), machine learning (ML), artificial intelligence (AI)
- **Next Steps:**
  - Develop first nuclear facility digital twin at DOME incorporating physics-based modeling, predictive machine learning, real-time data feedback, etc.

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Integrating AI to the DOE Authorization Process

2024: Developed Architecture for Leveraging Digital Tools:

- Mapped semi-autonomous DOE Authorization Documents
  - NRIC digital engineering tools: DOORS, DeepLynx, Windchill.
  - Single source of truth using the digital thread
  - AI large language models for document creation
  - Graphical user interface (GUI) to accelerate reviews

2025: Pilot project demonstration:

- Enhanced digital thread for Artificial Intelligence (AI) integration
- Pilot project is High Temperature Gas Reactor (HTGR) in NRIC-DOME
  - Create input documents - Sep 2025
  - AI generated nuclear safety document – Dec 2025

Challenges:

- Government cloud limits AI capabilities; Investigating opportunities

Impacts:

- 30-50% decrease in time to develop and review safety documents
- Accelerated authorization reviews to support rapid authorization of test bed experiments
- Future application to Nuclear Regulatory Commission (NRC) reviews to accelerate deployment

Evaluating Maritime Applications

Maritime Nuclear Application Group:

- Collaboration with ABS and Morgan & Lewis Law Firm
- Research Hub and Resource Center
- 190 members representing 80+ companies

Published five reports under ABS iFOA Award:

- Road Map for the Development of Commercial Maritime Applications of Advanced Nuclear Technology
- Configurations of Commercial Advanced Nuclear-Maritime Applications
- Potential Challenges and Impacts of Advanced Nuclear-Maritime Applications in the U.S.
- Readiness for DOE Support of Maritime-Related Demonstration Projects of Advanced Nuclear Technology
- Overcoming Challenges to Nuclear-Maritime Applications

Ongoing efforts:

- US/UK Maritime Nuclear Corridor Collaboration
- Oil and gas concept
- Reactor Technology Suitability
- Port siting study
- Maritime/Nuclear language guide

*MNAG is a **research hub** and **resource center** that brings together experts from the maritime and nuclear energy sectors to facilitate the demonstration of advanced nuclear technologies for a range of marine applications.*

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3/11/2026

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